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**(54) Method of stabilizing beverages**

Verfahren zur Getränkstabilisierung

Procédé de stabilisation de boissons

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(73) Proprietors:  
• **Intermag GmbH**  
**55294 Bodenheim/Rh. (DE)**  
• **Amersham Biosciences AB**  
**751 84 Uppsala (SE)**

(72) Inventors:  
• **Katzke, Michael**  
**55234 Flomborn (DE)**  
• **Berglöf, Jan**  
**754 41 Uppsala (SE)**  
• **Vretblad, Per**  
**756 52 Uppsala (SE)**  
• **Nendza, Ralf**  
**79112 Freiburg (DE)**

(74) Representative: **Rollins, Anthony John**  
**Amersham plc**  
**The Grove Centre**  
**White Lion Road**  
**Amersham, Buckinghamshire HP7 9LL (GB)**

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- **Food Technology in New zealand, Volume 10, No. 30, 1985, Roy Hughes, "Resins solve food processing problems"**
- **Dialog Information Services, File 351, WPI, Dialog accession no. 007947452, WPI accession no. 89-212564/29, LISYUK G M: et al: "Stabilisation of beer - is carried out by heating to specified temp., adding strongly basic anionite as sorbent, stirring and decanting"; & SU,A,1451159, 890115, 8929 (Basic)**

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**EP 0 806 474 B1**

**Description****Technical field**

- 5 [0001] The present invention relates to beverage stabilization, more precisely to a method for stabilization of beverages by removing haze-forming substances using an ion exchanger.

**Background of the invention**

- 10 [0002] The quality of beverages is measured by different parameters, such as flavour stability, biological purity and physico-chemical stability, wherein the latter is one of the most important for beer. The physico-chemical or colloidal stability describes the occurrence of non-biological haze in bottled beverages, such as beer. This haze is mainly caused by polyphenols and proteins, which are able to react to larger molecules via hydrogen bridges. The haze-forming proteins are believed to have Mw within the range of 30-60 kDa, although the range may differ depending on source.
- 15 When removing proteins with Mw above 120 kDa, the head retention of the beer decreases. Members of the polyphenol group are, inter alia, tannins and anthocyanogens which measured separately can be used as indicators for beer stabilization. To increase the beer's stability it is usual to remove partly the polyphenols, the proteins or both by using various agents and methods. The normally desired shelflife for stabilized beer is about 6 months, with variations for different countries and/or kind of beer.

- 20 [0003] Stabilization and clarification of beverages are two terms that sometimes are used interchangeable and sometimes as distinct concepts. In a strict sense clarification refers to the removal of haze and particulate matter that are at hand in a given beverage while stabilization refers to the removal of potentially haze-forming substances in order to render haze formation more difficult. In the context of the present invention the two terms shall be interpreted in a strict sense.

- 25 [0004] The amount of haze-forming substances and their tendency to form haze depends on several factors. See the experimental part. Each beer, for instance, is unique in composition depending on the brewery's selection of process variables, quality of hop and barley etc. This means that an acceptable level of stability/stabilization as measured by commonly accepted tests may vary between type of beer and/or brewery. In connection with the invention fixed limits for stabilization are therefore hard to be set. As a general guideline it can be said that stabilization has occurred when
- 30 a value for a test measuring both haze-forming proteins and polyphenols has been changed at least 10% towards stabilization as a consequence of employing the invention. This means that a similar change or even lower change may apply to tests measuring proteins and polyphenols separately. The goal with stabilization is not to remove all haze forming proteins and/or polyphenols, because this might easily also affect the character of a specific beverage.

**Background publications**

[0005] The problems with haze-causing substances in beverages have been known for several years and a number of solutions for removal thereof have been suggested.

- 40 [0006] The most common way to remove polyphenols from beverages is to use polyvinyl pyrrolidone, PVP. Before addition to the beverage, PVP has to be mixed with water to form a slurry. PVP is added to the storage tank or dosed into the beer stream before the beer filter and filtered out with other haze particles. PVP is available in two qualities: single use and re-usable differing in particle size.

- 45 [0007] From SU 1 451 159 a process is known for beer stabilization using an ion exchange sorbent for removing polyphenols. In this process, the beer is warmed to 65-75°C, and a strongly basic macro crosslinked sorbent (anion exchanger) based on copolymers of styrene and 4% divinyl compound containing functional quaternary trimethylamine groups is added. This hydrophobic sorbent is added to beer in amounts ensuring the removal of 25-30% of the polyphenols, stirred, left to stand 2-3 min., and the beer is decanted. The sorbent has a polyphenol sorption capacity of 18-19 mg/g, can be reused for at least ten times, and is regenerated with 5 parts per volume water at 45-50°C.

- 50 [0008] From Rep. Res. Lab. Kirin Brew.Co. (1972), No. 15, 17-24 an anion exchanger (Dowex 1 x 4 resin) is used for fractionation of polyphenols in beer. First the polyphenols are extracted from beer, such as by ethyl acetate, then this extract is subjected to anion exchange chromatography in the purpose of fractionating the polyphenols into several groups for further studies. Thus, the anion exchanger is not used for stabilization of beverages.

- 55 [0009] In Europe, one of the most common ways for removing proteins from beer is treatment with silica in the form of a slurry in water. The silica gel is added to the storage tank or is constantly dosed into the beer stream before the beer filter. The silica gel is filtered out with other haze particles and is wasted after use.

- [0010] Another widely used method for the removing proteins is treatment with tannic acid. After preparing a solution of tannin and water, the tannin is added to the storage tank or is constantly dosed into the beer stream before the beer filter. The tannin is filtered out with other haze particles and is wasted after use.

[0011] Also, there exist alternative agents for removing proteins from beverages containing haze-forming substances, such as proteolytic enzymes or bentonite.

[0012] The fact that the widely used silica gel and tannins are not re-usable, makes them substantial contributors to environmental pollution.

[0013] During the priority year the Swedish Patent Office has issued an International Search Report citing the following publications:

- a. US-A-4,100,149 that deals with the removal of proteins from beer and other beverages in order to accomplish, for instance, a clarified beer. The adsorbent used is built up of polymer coated inorganic particles. The polymer carries ion exchange groups. The experimental part focuses on coated silica particles, and it is not clear if the effect achieved is due to the silica, polymer coat or charged groups.
- b. EP-A-166,238 deals with neutralizing the bacteriostatic activity of polyphenols in fruit juices by addition of an agent that may or may not have ion exchange groups.
- c. Hughes, Food Technology in New Zealand, 10(30) (1985) suggests that cellulosic ion exchangers could be used to stabilize beer because they are known to adsorb proteins.
- d. US-A-4,288,462 suggests that a filter element charged with anionic colloidal silica can be used for removing haze and haze-forming proteinaceous substances in beverages, such as beer.
- e. US-A-3,623,955 concerns removal a certain enzyme from beer.
- f. US-A-3,940,498 suggests to use an acid treated synthetic magnesium silicate for the simultaneous removal of undesirable proteins and polyphenols from beverages such as beer.
- g. WPI acc. no. 89-212564/29 is the same as SU 1,451,159 which has been discussed above.

Some additional publications are:

- h. WPI acc. no 81-81725D (= DD-A-150,078) suggests the use of particulate hydrophobic material exhibiting groups capable of H bridge formation, ion exchange, chemisorption or chelation for the removal of turbidity-forming materials from drinks, including beer.
- i. WPI acc. no. 81-15897D (GB-A-2,056,485) suggests using positively charged particles for removing substances causing cloudiness in beverages (wine, beer, fruit juices etc). The charge has been introduced by treating the particles with a cationic polyamide-polyamine epichlorohydrin synthetic material. When contacted with the beverage the particles provoke precipitation that later can be removed by filtration.
- j. WPI acc. no. 77-09751Y (= GB-A-1,499,849) suggests to remove haze precursors in beverages by the use of cation exchangers based on hydrophobic matrixes.

## Summary of the invention

[0014] The present invention provides a method for the removal of polyphenols and proteins simultaneously from a beverage by contacting the beverage with an ion exchanger that is capable of adsorbing both types of substances. The characteristic feature of the ion exchanger to be used is that it is a water-insoluble porous hydrophilic matrix to which ion exchanging groups are covalently bound, which matrix is of >50% by weight of organic origin saturated with beer or water. The method also includes a regeneration step.

[0015] Physically the matrix may be in the form of a fixed bed consisting of packed porous beads/particles or a porous monolith or a membrane (continuous matrixes). The shape of the beads/particles may be spherical or irregular. In the alternative the matrix may be in the form of a fluidized bed that may be unmixed (classified, stabilised, expanded) in order to allow chromatography, or completely mixed as used in batch-wise procedures.

[0016] The matrix may be built up of a polymeric network exposing hydrophilic groups, such as hydroxy groups and/or amide groups, on the surface that is to contact the beverage during the inventive stabilization method, i.e. both on outer surfaces and on pore surfaces. Suitable polymers are mostly organic and of biological origin (biopolymers), although also fully synthetic polymers are also contemplated. Examples of useful biopolymers are polysaccharide gels made from dextran (Sephadex®, Pharmacia Biotech AB, Uppsala Sweden), agarose (Sephacrose®, Pharmacia Biotech AB, Uppsala Sweden), starch, cellulose (Sephacel®, Pharmacia Biotech AB, Uppsala Sweden) etc that have been substituted with the appropriate ion exchanging groups and possibly also cross-linked. Appropriate examples of synthetic polymers are polymers of hydroxyalkyl acrylates or methacrylates, hydroxy alkyl vinyl ethers, acryl or methacryl amides that optionally are N-substituted etc. The above-mentioned biopolymers and synthetic polymers have a pronounced hydrophilic character because they carry hydroxy and/or amide groups along their polymer chain. Also purely hydrophobic polymers, such as polystyrenes including styrene-divinyl benzene copolymers, may be used. In the latter case it becomes imperative that the pore surfaces of the matrix have been hydrophilized, for instance by being coated (physical adsorption or grafted) with a substance that provides the appropriate hydrophilicity, for instance

the above mentioned hydroxy-group containing polymers or a low molecular weight hydroxy group containing compound (SOURCE™, Pharmacia Biotech AB, Uppsala, Sweden).

[0017] The matrix, in particular in case it is in beaded form, may contain inorganic material, although as suggested above the main constituents are of organic origin, i.e. > 50% by weight (saturated with beer or water).

[0018] It is important that the porosity of the gel is sufficiently high to allow for penetration of the beverage destabilizing proteins and polyphenols. Accordingly the gel should be permeable to haze forming proteins and polyphenols and hence permeable to globular proteins below  $10^7$ , often below  $5 \times 10^6$  Dalton. The ion exchange capacity is typically within the range 0.05 - 0.50 mmol per mL packed bed.

[0019] The ion exchanging groups may be cation exchanging or anion exchanging. Examples of cation exchanging groups are carboxy ( $-\text{COO}^-$ ), sulphonic acid ( $-\text{SO}_3^-$ ), phosphonic acid groups etc. Examples of anion exchanging groups are quarternary, tertiary, secondary and primary amino groups ( $-\text{N}^+(\text{R}_1, \text{R}_2, \text{R}_3)$ ). The free valence indicates a covalent link to the matrix and is typically through an organic spacer structure, for instance pure alkylene or hydroxy alkylene.  $\text{R}_{1,3}$  is typically hydrogen or lower alkyl ( $\text{C}_{1-6}$ ) that may be substituted with one or more hydroxy groups. Among the quarternary amino groups may, in particularly, be mentioned  $-\text{N}^+(\text{CH}_3)_3$  that when linked to the matrix via the spacer  $-\text{CH}_2\text{CHOHCH}_2-$  is called a Q-group. In the experimental part SP Sepharose® and CM Sepharose® are used. CM (carboxymethyl) in CM Sepharose® stands for  $-\text{OCH}_2\text{COO}^-$  that is substituting an OH group directly linked to the base matrix (agarose). SP (sulfopropyl) stands for  $-(\text{CH}_2)_3\text{SO}_3^-$  that is substituting an OH group of the base matrix (agarose) via a linker  $-\text{OCH}_2\text{CHOHCH}_2\text{O}-$ .

The steps of the inventive method comprises a. contacting the matrix with the beverage to be stabilized with one of the above-mentioned ion exchangers under conditions permitting adsorption of the destabilizing proteins and phenols, b. recovering the beverage from the ion-exchanger, and c. regeneration of the ion exchanger by contacting it with a solution for regeneration, for instance containing sodium hydroxide and sodium chloride and water only. As indicated above the contacting may be carried out by allowing the beverage to pass through a vessel (e.g. a column) containing the ion exchanger in any of the above-mentioned forms. Typically the regeneration solution is allowed to pass through in a direction that is opposite to the direction of the beverage. The process may be continuous or in a batch-wise form. After the beverage has been in contact with the ion exchanger there often is no imperative need of a further filtration step. Compare the experimental part. Typically for beer, the temperature, at least during the contact with the ion-exchanger, is above the freezing point for beer and below  $+10^\circ\text{C}$  such as below  $+5^\circ\text{C}$ . Most breweries today work at about  $0^\circ\text{C}$ , which for practical reasons is preferred also in the inventive method. Also other steps conventionally used within the technical field of beverage stabilization may be included.

### Best Mode

[0020] The best mode known at the priority date of the inventive method comprises the regeneration step as described above. The ion exchanger used is an anion exchanger of the Q-type (Q-Sepharose®) in form of macro beads (mean particle size of  $200 \mu\text{m}$ ) packed in column through which the beverage is allowed to flow. Q-Sepharose® is permeable to globular proteins of  $4 \times 10^6$  Dalton and has an ion exchange capacity of 0.18-0.25 mmol per mL packed bed. The temperature is around  $0^\circ\text{C}$ . See also Example 4.

### Detailed description of the invention

[0021] The invention will now be described more closely below in association with some non-limiting Examples. The Examples are all related to beer but it is to be understood that the method according to the invention is equally applicable on other solutions, for example beverages other than beer, containing haze-forming substances.

## EXPERIMENTAL PART

### Materials and methods

[0022] In the Experiments, the following analysis were carried out to describe the stability of beer.

TABLE A

Analysis	Determination	Litterature/Source
Ammonium sulphate precipitation	Haze-causing protein	MEBAK*, 1993, P. 164-165

\* MEBAK is an abbreviation of Mitteleuropäische Brautechnologische Analysenkommission.

TABLE A (continued)

Analysis	Determination	Litterature/Source
Alcohol-chill-test (ACT)	Haze-causing polyphenols and proteins. Beer stability.	MEBAK*, 1993, p.160-162
Polyphenols, total	Polyphenol content	MEBAK*, 1993, p.169-170
Anthocyanogens	Anthocyanogen content	MEBAK*, 1993, p.171-172
Accelerated Ageing test, 0/40°C	Beer stability	MEBAK*, 1993, p.157-158

\* MEBAK is an abbreviation of Mitteleuropäische Brautechnologische Analysenkommission.

### 1. Protein sensitive tests:

#### [0023]

1.1. Ammonium sulphate precipitation. When adding a saturated ammonium sulphate solution to beer, a haze of precipitated proteins is formed. The more ammonium sulphate solution is needed to cause this haze, the more the beer is stabilized.

1.2. "Esbach-test". High molecular weight proteins will be precipitated with "Esbach-reagent" (picric acid - citric acid solution). The addition of the reagent will cause a haze which can be measured photometrically.

### 2. Polyphenols

#### [0024]

2.1. Polyphenols total. All polyphenols, preferably those with vicinal hydroxyl groups, are measured. The polyphenols react in caustic solution with iron ions to coloured iron complexes, which can be measured photometrically.

2.2. Anthocyanogens are phenolic substances which will be turned into red-coloured anthocyanidines by the treatment of hydrochloric acid.

### 3. Tests for the determination of beer stability.

#### [0025]

3.1. Alcohol-chill-test. When chilling beer, a reversible haze is formed, caused by precipitated polyphenol-protein complexes. The addition of alcohol decreases the solubility of these complexes and accelerates the precipitation.

3.2. Accelerated ageing test. Beer is stored at 0°C and 40°C or 60°C until haze of 2 EBC units can be recognized. The haze is caused by the precipitation of polyphenol-protein complexes.

[0026] Beer stability is a complex feature and depends on several variables, including protein and/or polyphenol content. The Alcohol-chill-test and the Accelerated-ageing test show a linear relation to stabilization. The tests under item 1 and 2 above do not show a linear relation.

[0027] The following ion exchangers were tested for use in the method according to the invention.

TABLE B

Ion exchanger	Functional group	Exclusion limit (Daltons)	Mean bead size (µm)
Anion exchangers:			
Q Sepharose® Fast Flow	quaternary ammonium	4 x 10 <sup>6</sup>	90
Q Sepharose® Big Beads	"-	"-	200
SOURCE™ 30Q	"-	≤10 <sup>7</sup>	30
DEAE Sephacel®	diethyl amino ethyl	1 x 10 <sup>6</sup>	100
Cation exchangers:			
SP Sepharose® Fast Flow	sulpho propyl	4 x 10 <sup>6</sup>	90
SP Sepharose® Big Beads	"-	4 x 10 <sup>6</sup>	90

TABLE B (continued)

Cation exchangers:			
CM Sepharose® Fast Flow	carboxy methyl	4 x 10 <sup>6</sup>	90

All the Experiments were run at a temperature of about 0°C and without any pretreatment of the filtered beer.

### Experiment 1

[0028] For Experiments 1 and 2, a chromatography column with an inner diameter of 50 mm (Pharmacia XK 50/20) was packed with 60 ml Q Sepharose® Big Beads. Then several liquids were pumped through the column according to the following C.I.P. (cleaning in place) program:

- 800 ml water, 10 min.
- 1000 ml 1 M NaOH, 60 min.
- 500 ml water, 10 min.
- 500 ml 2M NaCl, 30 min.
- 500 ml water, 10 min.

[0029] This program was also carried out after each run with beer for regeneration of the columns. 30 l filtered and unstabilized beer was pumped through the packed column with a flow rate of 6 l/h. This beer was collected, analyzed and the datas compared with untreated beer. The results are given in Table I below.

TABLE I

Treatment of beer	ml NH <sub>4</sub> SO <sub>2</sub> /100 ml beer	ACT EBC units	Polyphenols mg/l	Anthocyanogenes mg/l	Accel Ageing test, days 40°C
untreated	10	10.8	205	49	1.5
Q Sepharose®	15	4.4	164	35	18
* EBC is an abbreviation of European Brewery Convention. Reference for EBC unit is a mixture of hydrazine sulphate and hexamethylene tetramine (formazine): 1 absolute unit = 9 000 units Helm = 15 500 EBC units.					

### Experiment 2

[0030] 50 l filtered and unstabilized beer was pumped through the packed column with a flow rate of 7.8 l/h. This beer was collected, analyzed and the datas compared with untreated beer. The results are given in Table II below.

TABLE II

treatment of beer	ml NH <sub>4</sub> SO <sub>2</sub> per 100ml beer	ACT EBC units	Polyphenols mg/l	Anthocyanogenes mg/l	Accel. Ageing test, days 40°C
untreated	7	10.2	201	54	1.2
Q Sepharose®	11	8	188	45	8

[0031] As appears from Table I and II, beer treated with Q Sepharose® had less polyphenols and anthocyanogens than the untreated beer. The protein-sensitive ammonium sulphate precipitation showed a reduction of protein in the treated beer. Furthermore, the results of the alcohol-chill-test and the ageing test showed that the colloidal stability of beer treated with Q Sepharose® was clearly better than the corresponding values for the untreated beer.

### Experiment 3: Comparison of different ion exchangers

[0032] In this Experiment, for each ion exchanger, a column with an inner diameter of 10 mm was packed with 3 ml ion exchanger, washed and equilibrated with 100 ml buffer (ethanol 4.5 % v/v, adjusted to pH 4.5 by citric acid). Then 500 ml of filtered, unstabilized beer was pumped through each packed column.

[0033] Silica gel (FK700 from Degussa, Germany) was used for comparative purposes.

[0034] The thus treated beer was collected, analyzed and the datas are given below in Table III and IV, respectively.

TABLE III

Sample	Haze (EBC) after adding 15 ml $\text{NH}_4\text{SO}_4$ /100 ml (EBC units)
untreated beer	10
silica gel	1,1
Q Sepharose® Fast Flow	4,2
Q Sepharose® Big Beads	4,8
SP Sepharose® Fast Flow	6
SP Sepharose® Big Beads	6
CM Sepharose® Fast Flow	10

[0035] As appears from the Table, besides silica gel, Q Sepharose® led to the highest reduction of haze-causing proteins in beer. SP Sepharose® also had some stabilizing effect while CM Sepharose® had no effect at all compared with untreated beer.

TABLE IV

Sample	Haze after adding 15 ml $\text{NH}_4\text{SO}_4$ /100 ml	Alcohol-chill test (EBC units)
untreated	10.0	25.0
silica gel	1.7	4.8
SOURCE™ 30Q	4.2	18
DEAE Sephacel®	4.7	5.6
Q Sepharose® Big Beads	4.7	4.5
Q Sepharose® Fast Flow	5.2	3.0

[0036] It appears that SOURCE™ 30Q had the best protein adsorbing properties but the result of the alcohol-chill test with this product was poor. Q Sepharose® Big Beads and DEAE Sephacel® had nearly comparable stabilizing properties and the good results of the alcohol-chill test indicated a good stability of the treated beer by the additional adsorption of polyphenols. Compared to DEAE Sephacel®, Q Sepharose® has a higher chemical stability, which is an important advantage for the cleaning and sanitation process in the brewing industry.

[0037] The preferred ion exchanger according to the invention is Q Sepharose® Big Beads in respect of beer stabilizing properties, permeability and chemical stability.

#### Experiment 4: Large scale beer stabilization

[0038] This experiment was carried out in a brewery under practice conditions. In this brewery the beer is usually stabilized by using 15 g PVPP/hl and 30 g silica gel/hl.

[0039] For experiment 4 a chromatography column with an inner diameter of 30 cm (Pharmacia BPG 300) was packed with 9 liter of Q Sepharose® Big Beads. The bed height of Q Sepharose® in the packed column was 13 cm. Then several liquids were pumped through the column (C.I.P. program):

- 200 liter water, 10 min.
- 30 liter 2 M NaCl, 20 min.
- 40 liter water, 15 min.
- 40 liter water, 15 min.
- 30 liter 1 M NaCl, 20 min.
- 40 liter water, 15 min.

This program was also carried out after each run with beer.

[0040] 145 hl filtered an unstabilized beer was pumped through the packed column with a flow rate of 10 hl/h. This beer was collected and analyzed. The datas were compared with untreated beer and with beer stabilized as usual from the normal production (15 g PVPP/hl and 30 g silica gel/hl). The results are given in the table V below.

Table V

treatment of beer	ml NH <sub>4</sub> SO <sub>2</sub> / 100 ml beer	ACT, EBC units	Anthocyanogenes mg/l	Accelerated Ageing test, days at 40°C
untreated	11	15.1	65	1.4
Q Sepharose®	13	11.2	48	7.8
normal (15 g PVP/hl) (30 g silica/hl)	19	10.9	52	8

[0041] As appears from the table, beer treated with Q Sepharose® had less anthocyanogenes than the untreated beer. The protein-sensitive ammonium sulphate precipitation showed a reduction of protein in the treated beer. The results of the alcohol-chill test and the ageing test showed that the colloidal stability of beer treated with Q Sepharose® was much better than the untreated beer. Compared with the normal treatment for stabilization of beer, Q Sepharose® has adsorbed slightly less protein but more anthocyanogenes. The stabilizing effect, described with the alcohol-chill test and the ageing test, shows comparable results. This means that beer treated with Q Sepharose® had the same colloidal stability as the PVPP and silica stabilized beer, whereas the stabilization with Q Sepharose® offers the following advantages:

1. Q Sepharose® combines the effect of protein and polyphenol adsorbing materials. Therefore only one material and step is necessary instead of two for a combined beverage stabilization.
2. Q Sepharose® is reusable, whereas a reusable protein adsorbing material and a combined reusable protein and polyphenol adsorbing material does not exist.
3. Because Q Sepharose® is reusable for more than 170 cycles, it causes much less environmental pollution than single use materials.
4. The beverage stabilization with Q Sepharose® is easy to handle and can be automated.
5. The stabilization process is separated from beverage filtration. This allows a simple and combined beverage stabilization independent from current and future filter systems.
6. Compared with i.e. enzymes used for beverage stabilization, Q Sepharose® is non-soluble.

[0042] A comparison of the flow rate with a common used kieselguhr filter is given in table VI below.

Table VI

	specific flow rate, hl/m <sup>2</sup> filter area·h
kieselguhr filter	1-2
Q Sepharose® packed column	141

[0043] As appears from the table, columns packed with Q Sepharose® allow very high flow rates.

## Claims

1. A method of stabilizing beverages containing haze causing substances by partly removing haze-forming proteins and haze-forming polyphenols, comprising the following steps:
  - a) contacting the beverage with a water-insoluble porous hydrophilic matrix to which ion exchanging groups are covalently bond, which matrix is of >50% by weight of organic origin saturated with beer or water;
  - b) recovering the beverage from the matrix; and
  - c) regeneration of the matrix.
2. The method according to claims 1, wherein the matrix is a fixed bed consisting of packed porous beads/particles, a porous monolith or a membrane.
3. The method according to claims 1 or 2, wherein the matrix comprises a polymeric network exposing on its surfaces hydrophilic groups.

4. The method according to claim 3 wherein the polymeric network on its surfaces exposes hydroxy groups.
5. The method according to claim 3 or 4, wherein the matrix is made of a hydrophilic polymer.
6. A method according to claim 5, wherein the hydrophilic polymer is selected from polysaccharides, polymers of hydroxyalkyl acrylates or methacrylates, polymers of hydroxyalkyl vinyl ethers, and polymers of acryl or methacrylamides that optionally are N-substituted.
7. The method according to any of claims 1-6, wherein the matrix is permeable to globular proteins below  $10^7$  Daltons.
8. A method according to any one of the preceding claims, wherein the ion exchanging groups are anion exchanging groups.
9. The method according to claim 8, wherein the anion exchanging groups are quaternary ammonium groups.
10. The method according to claim 9, wherein the quaternary ammonium groups are  $-\text{CH}_2\text{CHOHCH}_2\text{N}^+(\text{CH}_3)_3$ .
11. The method according to any one of the claims 1-7, wherein the ion exchanging groups are cation exchanging groups.
12. The method according to any one of claims 1-11, wherein the beverage is beer.
13. The method according to claim 12, wherein the method is run at a temperature below  $10^\circ\text{C}$  but above the freezing point for beer.
14. The method according to claim 13, wherein the method is run at a temperature below  $5^\circ\text{C}$ .
15. A method according to any one of claims 1-14, wherein the method is run continuously.

#### Patentansprüche

1. Verfahren zur Stabilisierung von Getränken, welche Trübung verursachende Substanzen enthalten, durch teilweises Entfernen Trübung bildender Proteine und Trübung bildender Polyphenole, umfassend die folgenden Schritte:
  - a) Kontaktieren des Getränks mit einer wasserunlöslichen, porösen, hydrophilen Matrix, an welche ionenaustauschende Gruppen kovalent gebunden sind, welche Matrix zu > 50% organischen Ursprungs ist, gesättigt mit Bier oder Wasser;
  - b) Rückgewinnen des Getränks aus der Matrix; und
  - c) Regeneration der Matrix.
2. Verfahren nach Anspruch 1, wobei die Matrix ein Festbett ist, bestehend aus gepackten, porösen Kügelchen/Teilchen, einem porösen Monolith oder einer Membran.
3. Verfahren nach den Ansprüchen 1 oder 2, wobei die Matrix ein polymeres Netzwerk umfaßt, auf dessen Oberflächen hydrophile Gruppen exponiert sind.
4. Verfahren nach Anspruch 3, wobei auf den Oberflächen des polymeren Netzwerks Hydroxygruppen exponiert sind.
5. Verfahren nach den Ansprüchen 3 oder 4, wobei die Matrix aus einem hydrophilen Polymer hergestellt ist.
6. Verfahren nach Anspruch 5, wobei das hydrophile Polymer gewählt ist aus Polysacchariden, Polymeren von Hydroxyalkylacrylaten oder -methacrylaten. Polymeren aus Hydroxyalkylvinylethern und Polymeren aus Acryl- oder Methacrylamiden, welche wahlweise N-substituiert sind.
7. Verfahren nach mindestens einem der Ansprüche 1-6, wobei die Matrix für globulare Proteine unterhalb  $10^7$  Daltons permeabel ist.

8. Verfahren nach mindestens einem der vorangehenden Ansprüche, wobei die ionenaustauschenden Gruppen anionenaustauschende Gruppen sind.
9. Verfahren nach Anspruch 8, wobei die anionenaustauschenden Gruppen quaternäre Ammoniumgruppen sind.
10. Verfahren nach Anspruch 9, wobei die quaternären Ammoniumgruppen  $-\text{CH}_2\text{CHOHCH}_2\text{N}^+(\text{CH}_3)_3$  sind.
11. Verfahren nach mindestens einem der Ansprüche 1-7, wobei die ionenaustauschenden Gruppen kationenaustauschende Gruppen sind.
12. Verfahren nach mindestens einem der Ansprüche 1-11, wobei das Getränk Bier ist.
13. Verfahren nach Anspruch 12, wobei das Verfahren bei einer Temperatur unterhalb  $10^\circ\text{C}$ , jedoch oberhalb des Gefrierpunktes von Bier durchgeführt wird.
14. Verfahren nach Anspruch 13, wobei das Verfahren bei einer Temperatur unterhalb  $5^\circ\text{C}$  durchgeführt wird.
15. Verfahren nach mindestens einem der Ansprüche 1-14, wobei das Verfahren kontinuierlich durchgeführt wird.

## Revendications

1. Procédé de stabilisation de boissons contenant des substances provoquant un trouble en éliminant partiellement les protéines formant un trouble et les polyphénols formant un trouble, comprenant les étapes suivantes :
  - a) la mise en contact de la boisson avec une matrice hydrophile poreuse insoluble dans l'eau, à laquelle des groupes échangeurs d'ions sont liés de façon covalente, cette matrice étant à  $>50\%$  en poids d'origine organique, saturée avec de la bière ou de l'eau ;
  - b) la récupération de la boisson à partir de la matrice ; et
  - c) la régénération de la matrice.
2. Procédé selon la revendication 1, dans lequel la matrice est un lit fixe consistant en billes/particules poreuses tassées, un bloc poreux ou une membrane.
3. Procédé selon les revendications 1 ou 2, dans lequel la matrice comprend un réseau polymère exposant des groupes hydrophiles sur ses surfaces.
4. Procédé selon la revendication 3, dans lequel le réseau polymère expose des groupes hydroxy sur ses surfaces.
5. Procédé selon la revendication 3 ou 4, dans lequel la matrice est composée d'un polymère hydrophile.
6. Procédé selon la revendication 5, dans lequel le polymère hydrophile est choisi parmi les polysaccharides, les polymères d'acrylates ou méthacrylates d'hydroxyalkyle, les polymères d'éthers hydroxyalkyl vinyliques, et les polymères d'acryl ou méthacrylamides qui sont éventuellement N- substitués.
7. Procédé selon l'une quelconque des revendications 1 à 6, dans lequel la matrice est perméable aux protéines globulaires inférieures à  $10^7$  daltons.
8. Procédé selon l'une quelconque des revendications précédentes, dans lequel les groupes échangeurs d'ions sont des groupes échangeurs d'anions.
9. Procédé selon la revendication 8, dans lequel les groupes échangeurs d'anions sont des groupes ammonium quaternaire.
10. Procédé selon la revendication 9, dans lequel les groupes ammonium quaternaire sont  $-\text{CH}_2\text{CHOHCH}_2\text{N}^+(\text{CH}_3)_3$ .
11. Procédé selon l'une quelconque des revendications 1 à 7, dans lequel les groupes échangeurs d'ions sont des groupes échangeurs de cations.

- 12.** Procédé selon l'une quelconque des revendications 1 à 11, dans lequel la boisson est la bière.
- 13.** Procédé selon la revendication 12, dans lequel le procédé est mis en oeuvre à une température inférieure à 10 °C mais supérieure au point de congélation de la bière.
- 14.** Procédé selon la revendication 13, le procédé étant mis en oeuvre à une température inférieure à 5 °C.
- 15.** Procédé selon l'une quelconque des revendications 1 à 14, le procédé étant mis en oeuvre en continu.

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L1 ANSWER 1 OF 1 WPINDEX COPYRIGHT 2004 THOMSON DERWENT on STN  
AN 1998-175157 [16] WPINDEX  
DNC C1998-056407  
TI Inorganic particle surface treatment method for composite material  
manufacture - involves mixing distributed liquid of inorganic particle and  
hydrolysis solution of silane coupling agent, after which drying is  
performed by spraying.  
DC E11 G01  
PA (TOKU) TOKUYAMA SODA KK  
CYC 1  
PI JP--10036705 A 19980210 (199816)\* 5p <--  
JP---3165787 B2 20010514 (200129) 5p  
ADT JP--10036705 A 1996JP-0198587 19960729; JP---3165787 B2 1996JP-0198587  
19960729  
FDT JP---3165787 B2 Previous Publ. JP--  
PRAI 1996JP-0198587 19960729  
AB JP 10036705 A UPAB: 19980421  
The method involves dispersing inorganic particle of mean particle  
diameter 0.005-5  $\mu$  m in a polar solvent such as water, methanol, ethanol  
and acetone. The particles include silica, silica titanium, silica  
zirconium. The silane coupling agent in the inorganic particle is  
hydrolysed by the hydrolysis agents like hydrochloric acid, nitric acid,  
acetic acid, citric acid. The hydrolysis solution and the distributed  
liquid of the inorganic particle are mixed and the particle surface is  
dried by spraying.  
ADVANTAGE - Reduces mechanical strength variation of particle. Avoids  
need for colouring composite material. Improves antiwear quality.  
Dwg.0/0

STN Columbus

L1 ANSWER 1 OF 1 WPINDEX COPYRIGHT 2004 THOMSON DERWENT on STN

AN 2002-693745 [75] WPINDEX

DNN N2002-547283 DNC C2002-196376

TI Surface reforming method of silica particle involves spraying silane coupling agent in air current to silica particle of preset average particle diameter, with specific silica dust concentration.

DC A60 A85 E11 E36 G01 L03 U11.

PA (ELED) DENKI KAGAKU KOGYO KK

CYC 1

PI JP2002146232 A 20020522 (200275)\* 4p

ADT JP2002146232 A 2000JP-0338825 20001107

PRAI 2000JP-0338825 20001107

AB JP2002146232 A UPAB: 20021120

NOVELTY - The surface reforming method of a silica particle involves spraying a silane coupling agent in an air current to silica particle of average particle diameter less than 5 microns . The with a silica dust concentration in the spray process is 0.1-100 g/m3.

USE - For reforming surface of silica particle used as filler of resin for sealing semiconductor device.

ADVANTAGE - The method performs uniform surface reformation in industrial scale.

L2 ANSWER 1 OF 1 WPINDEX COPYRIGHT 2004 THOMSON DERWENT on STN  
AN 1993-299014 [38] WPINDEX  
DNC C1993-132723  
TI Mercury removing agent prodn. for use in combustion appts. - by reacting  
silane coupling agent with diatomaceous earth.  
DC J01 M25  
PA (MITO) MITSUBISHI HEAVY IND CO LTD  
CYC 1  
PI JP--05212241 A 19930824 (199338)\* 6p  
ADT JP--05212241 A 1992JP-0018922 19920204  
PRAI **1992JP-0018922 19920204**  
AB JP 05212241 A UPAB: 19931123  
Method comprises (a) reacting silane coupling agent having a terminal  
gamma-mercapto gp., with inorganic powder of high specific surface area,  
or (b) reacting the silane coupling agent with diatomaceous earth or a  
mixture of diatomaceous earth and perlite. Pref. inorganic powder of  
specified specific surface area is added to water and stirred to produce  
(A), alcohol is added to silane coupling agent having gamma-mercapto gp.,  
stirred and dissolved to produce (B). (B) is reacted with (A) to produce  
the mercury removing agent.  
USE/ADVANTAGE - The agent is used for removing mercury (mercury and  
mercury cpd.) from exhaust gas from combustion appts. such as a trash  
burner or sewage sludge incinerator. The agent has excellent mercury  
removing action by the dry method and semi-dry method.  
In an example, silane liq. was added to ethyl alcohol. Acetic acid  
was added gradually and the silane was converted to silanol. Silicon  
dioxide was added to water. This liquid was added to the silanol liq.  
gradually with stirring. N-Propyl amine liq. was added as required. The  
liq. was stirred for 1 hour at room temp.. And slurry of mercury removing  
agent was obtained.  
Dwg. 0/0

STN Columbus

L1 ANSWER 1 OF 1 WPINDEX COPYRIGHT 2004 THOMSON DERWENT on STN

AN 1998-021958 [03] WPINDEX

DNC C1998-008172

TI Surface treatment for silica particles used in supports for absorbing antigens, cosmetics etc. - involves using silane coupler which reacts with silane alkoxide in particles to promote surface treatment.

DC A60 B04 D16 D21 E11 G02

PA (ATAT-N) A & T KK; (TOKU) TOKUYAMA SODA KK

CYC 1

PI JP--08119619 A 19960514 (199803)\* 8p

ADT JP--08119619 A 1994JP-0262925 19941026

PRAI 1994JP-0262925 19941026

AB JP 08119619 A UPAB: 19980119

Surface treatment is applied to silica particles using a silane coupler. A silane alkoxide compound of formula  $X_4-mSi(OR)_m$  (I) is contained in the silica particles.  $m = 2-4$ ;  $X = OH$  or halo;  $R_1 = alkyl$  or phenyl.

USE - The surface treatment controls the surface state of the silica particles. The resulting silica particles are used in various supports for adsorbing an antigen, or an antibody, or in an additive for various polymers, cosmetics, ink grease, or wax.

ADVANTAGE - (I) reacts with the silane coupling agent to promote the surface treatment. The method efficiently adds desired properties, or a desired functional group to the surface of the silica particles without complicated pretreatments, including drying the particles and solvent substitution.

Changing the amount of (I) easily adjusts the surface state.  
Dwg.0/1